CONTRACT [redacted]

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PAR 217 ILLEGIB
30 Nov 64

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SUBJECT: Optimization of Lasers

TASK/PROBLEM

1. Explore the production of 0.53 micron (blue-green) laser radiation by harmonic doubling in KDP and ADP crystals.

DISCUSSION

2. During this quarter, we optimized the 0.53 micron second harmonic power using a one-inch thick KDP crystal, but without the use of Q-switching techniques. The laser was a 12-inch long neodymium doped silicate rod mounted in a two meter long cavity. The KDP crystal was gimbal mounted and oriented to produce maximum second harmonic output. The long cavity was used to reduce the divergence in the fundamental beam, allowing a larger percentage of the radiation to strike the crystal at the proper angle. By lengthening the cavity from one to two meters, the harmonic output was increased by approximately a factor of 1.5.

3. The detectors used to measure the fundamental and harmonic output are standard phototubes. Their outputs charge a condenser in a high impedance circuit to a voltage which is directly proportional to the incident radiation. A schematic of this setup is shown in Figure 1. Currently, the crystal is generating in excess of four watts of harmonic power for a duration of about one millisecond.

4. The harmonic beam generated by the crystal is approximately one square centimeter in cross section, this being dictated solely by the dimensions of the crystal. To study this beam, therefore, we have inserted a lens in the beam path and displayed the resulting enlargement on a white matte paper positioned several feet from the lens. The beam, shown in print of Figure 2a, appears to have a lattice work or basket weave structure. It also displays large variations in density. To determine if this specific structure was an

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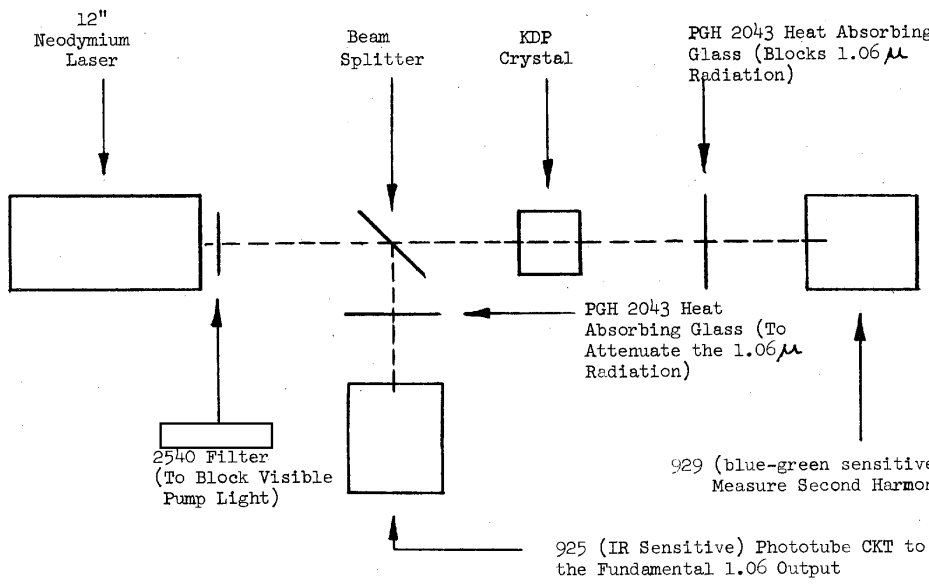


Schematic Diagram of System for Second Harmonic Generation of 0.56 Micron Laser Radiation

Fig. 1



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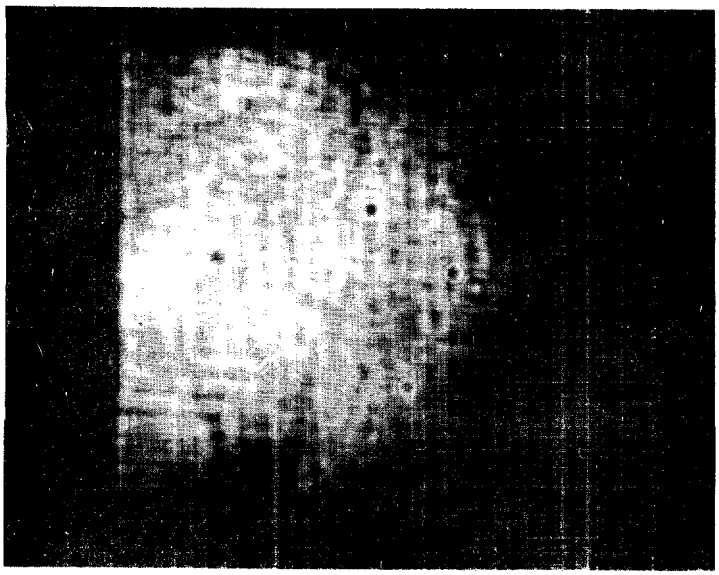

Figure 2a

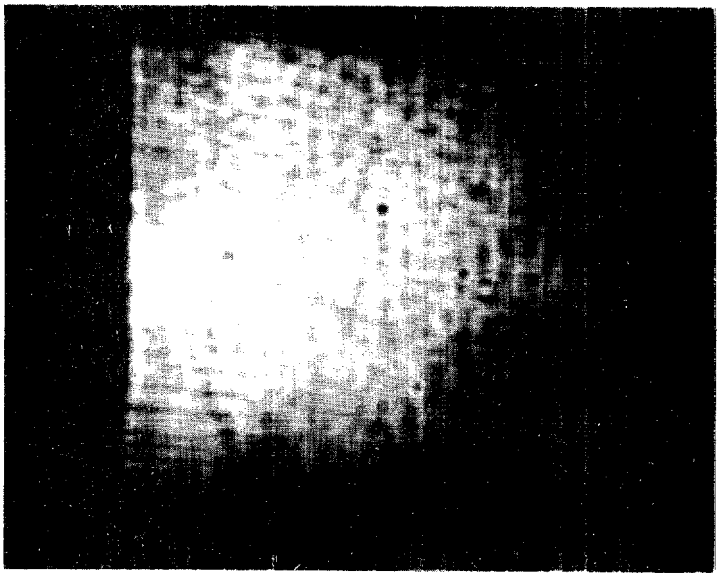

Figure 2b

Figure 2. Two Exposures of the Second Harmonic Beam to Show Beam Non-Uniformity (Note the similarity of the patterns selected at random from a series of several exposures.)

inherent characteristic of the laser beam, several additional exposures were made, one of which is shown in Figure 2b. The similarity between Figures 2a and 2b tends to indicate that this structure is not random. The structure may be due to the shape of the laser rod, it may be interference created by the KDP crystal edges, or it may be a characteristic of the crystal itself.

5. During this quarter, we have initiated a literature search on gas lasers producing radiation between 4000 and 7000 Angstroms. The search will include all pertinent information dating back to June 1963, and will be continued throughout the duration of this contract. Any significant results from this search will be reported in the monthly reports beginning January 1965.

6. In the proposal for PAR 217, a plasma pinch technique was suggested as a pump source to operate pulsed lasers at a high repetition rate. At that time, we attempted to familiarize ourselves with this new developmental technique and assembled a breadboard unit. This first attempt was unsuccessful, and we chose not to invest additional funds and time in developing a more sophisticated unit until we were convinced it would offer sufficient advantages. Since that time, the literature has indicated that extremely high voltage equipment is required and that the efficiency of this technique as a laser pump is extremely low. Therefore, we are not planning to continue with this approach.

PLANNED ACTIVITY

7. During the next quarter, we will:

a. Attempt to learn the reasons for the observed non-uniformity across the beam and to improve the uniformity.

b. Make a study of the technical literature since June 1963 on visible light lasers to attempt to make comparisons of reported performance of other systems with that achieved by harmonic doubling in this project.

8. Also during the next quarter, we intend to Q-switch the laser which should reduce the pulse length four or five orders of magnitude. This will increase the fundamental 1.06 micron power output, and will greatly increase the second harmonic power which is proportional to the square of the fundamental power. The higher harmonic output will permit attenuation of the beam to improve its uniformity.